

MALARIA IN AUSTRALIA

BY

P. A. MAPLESTONE

(Received for publication 25 February, 1923)

The following is a short account of the history of malaria in Australia as far as it can be collected from the published records. In compiling this review all the information prior to the year 1912 has been taken from Cleland (1914); since 1912 the original articles in the medical press and the various Government reports have been consulted. This is not a complete discussion of all the references to malaria in Australia; many of the earlier accounts are given by laymen, or are merely the expression of an opinion by a medical man without definite proof, and a considerable number of the later records are purely of local interest, so they have been ignored. In discussing the subject, the various States and the Northern Territory of the Commonwealth are considered separately.

QUEENSLAND

According to Cleland (1914), the first account of malaria in Australia by a medical man is that of White (1867). In all probability this is the same outbreak as the one to which Elkington (1912) refers, and which he concludes was introduced to Burketown by a ship from Java. Cleland mentions that for some years prior to 1885 there was extensive and severe malaria in North Queensland. In support of this statement he quotes the following authorities, viz. :—A'Heerne (1890) for Townsville, Graham-Browne (1890) for Charters Towers, Hunt (1890) for Hughenden, and James (1891) for Croydon. But from the quotations taken by

Cleland from these authors' writings it is by no means clear that all the epidemics included in this series were due, altogether or even partly, to malaria. For instance, there is no way of finding out if all A'Hearne's cases were malaria; Graham-Browne's description of the Charters Towers epidemic is unlike malaria; Hunt obviously confuses typhoid fever and malaria, and James under the term 'Gulf fever' describes all his febrile cases, some of which were probably malaria. For the same period Jeffris-Turner says he only saw three cases of malaria in children in Brisbane. Whatever these various outbreaks were, it is a striking fact that since the advent of more accurate diagnostic methods, malaria has not been recorded from any of the above towns, but enteric fever is fairly often encountered there.

From Cleland's account it appears that O'Brien (1908) was the first to record finding the malaria parasites in Australia; nearly all his cases were simple tertian, but he writes of finding a few quartan and malignant tertian. O'Brien's observations were apparently made at Yarabah mission station near Cairns. Breinl (1911), without quoting an authority and after only a few months in the country, reported malaria to be epidemic in 'parts of Queensland,' mentioning specifically Innisfail, Cooktown, and Saxby River. Nevertheless, he evidently saw some malaria, as he adds that the locally acquired cases were simple tertian, and that the few cases of malignant tertian that he saw were infected in Papua (=British New Guinea).

Elkington (1912) refers to a localised epidemic of malaria, which occurred at Kidston on the Einasleigh gold field in 1910. There were 120 cases and 24 deaths in a population of 400. The outbreak was investigated by Dr. Baxter-Tyrie, who concluded that the disease had been introduced from New Guinea. From the latter's report Elkington concludes that malignant malaria and blackwater fever are endemic; there is no further reference to this 'endemic' centre in the medical literature nor in the Government reports, therefore it is clear that Elkington's conclusion was premature. Neither is there any evidence that malaria spread from Kidston to any of the surrounding camps.

Although a few cases of malaria undoubtedly occur annually in the coastal districts of North Queensland, there is no way of finding out their numbers. In the Annual Health Report for the State, acute malaria first appears as a notifiable disease in the period 1st July, 1915, to 30th June, 1916. The figures up to the present time are given in Table I.

TABLE I.

Cases of malaria notified in Queensland.

Year	No. of cases
1915-1916	79
1916-1917	213
1917-1918	72
1918-1919	10
1919-1920	9
1920-1921	9
1921-1922	19

Unfortunately there is no way of ascertaining how many of the above cases were contracted in Queensland, and how many came from elsewhere, except that in 1916-1917 the Sanitary Inspector of the Northern District states in his report that 119 cases of malaria occurred in Cairns for that year. It can also be found indirectly, by comparing the above figures with those of the Australian Institute of Tropical Medicine for corresponding periods, that nearly all the remaining cases were returned soldiers who had become infected outside Australia.

Although this information is very incomplete it is quite obvious that the Cairns epidemic was short-lived and that not many cases can be occurring there at the present time. A possible explanation of this short epidemic in Cairns is that this is the first port of call for boats coming from New Guinea to Australia. In the period immediately preceding and during the sudden increase in malaria in this town, large numbers of soldiers returning from New Guinea were calling there, and the majority of them were being sent home because they were suffering from malaria. The extra opportunity for the mosquitoes of Cairns to become infected soon reacted on the local inhabitants; but in 1918, when traffic between New Guinea and Australia returned to normal and fewer persons with malaria parasites in their blood were calling at Cairns, the incidence of malaria there suddenly dropped and has remained low ever since. It is true that Breinl and Taylor (1918), after a malaria and mosquito survey of the town recommended the filling and draining

of various swamps in and around it ; but the drop in malaria incidence cannot be explained in this manner, because Mr. Hill, Entomologist of the Australian Institute, visited Cairns in 1921 and at the writer's request examined the mosquito-breeding places recorded by Breinl and Taylor in 1918. He reported that little had been done in reducing these breeding places.

Dr. H. H. Willis, in a letter to the writer in May, 1921, informed him that while on a 'hookworm' survey of the native settlement on the Palm Islands he had found nine or ten* cases of acute malaria which he had diagnosed microscopically. Over a month later the writer visited these Islands ; he examined all the natives (over 300) and found that five or six* of the cases reported by Willis had crescents in their blood. All the other natives were negative on blood examination, no palpable spleens were found although there were numerous children, and no fresh cases had occurred between the visits of Willis and the writer. The evidence of the origin of this small outbreak was not satisfactory, but as far as could be gathered it seemed likely that the malaria had been introduced from the mainland by some recent arrivals. It is remarkable that the outbreak did not spread further, because the natives were living closely congregated in unscreened grass huts, and Hill found Anopheline mosquitoes breeding close to the dwellings (see Table VI).

The history of Townsville during recent years from the point of view of malaria is of considerable interest, because since the establishment of the Australian Institute of Tropical Medicine in 1910, more reliable records are available from there than from any other town in Northern Australia. Many parasite carriers have been constantly arriving in Townsville for treatment during the eleven and a half years January, 1910 to June, 1921, and for the whole of that time no case of malaria has ever been discovered which was contracted in the town or its surroundings. There is also abundant evidence that the same species of Anophelines are found as in other Coastal towns where malaria occurs. Townsville is well within the tropics and is by far the largest town in Northern Australia with a population of about 25,000, nearly all of whom are whites.

* Figures from memory.

THE NORTHERN TERRITORY

Again consulting Cleland (1914) it is found that Wood (1889) said that malaria was very prevalent in the Northern Territory during the years 1879, 1880, and 1881. Holmes (1913) gives the following figures taken from the official records :—

TABLE II.
Deaths in the Northern Territory.

Year	Total Number of deaths	Deaths due to ' fever '
1879	166	61
1880	154	61
1881	100	51

It was at this time that gold-mining was at its height and there were many mining camps in the country with no medical man near them and no sanitary precautions in force. Although many of the deaths were in all probability due to malaria, it should be borne in mind that a large number of the cases could not have been seen by a medical man, so that the diagnosis of ' fever ' on the death certificates is not of much use for accurate record.

The Umbrawarra tin mining field was opened up about the year 1909 and shortly afterwards malaria broke out there. This epidemic was authenticated by Breinl (1912) who gives an account of it. The record is of considerable value, because the epidemic is shown to be due beyond all doubt to malaria, and the conditions at Umbrawarra were, in all probability, identical with those obtaining on mining fields in earlier times where similar epidemics occurred. These rushes to new mineral discoveries attract men from other parts of the world, and all the mining camps of Northern Australia have contained men from New Guinea, which is a highly malarious country. In the case of Umbrawarra, Breinl traced the origin of the outbreak to miners from New Guinea arriving with parasites in their blood ; from this fact it seems most likely that the earlier epidemics on other mining fields in the same regions of Australia were due to a like cause. The Umbrawarra epidemic came to an abrupt end, primarily by the departure of the majority of the miners, for in 1913, when the writer visited the field, there were only two miners remaining ;

but it is strange that the disease did not spread to Pine Creek, a permanent settlement only thirteen miles distant and which during the height of the activities at Umbrawarra was in daily communication with it, receiving all the men who were seriously ill and many of whom must have had malaria parasites in their blood. The same species of Anopheline has been recorded from both places.

Breinl and Holmes (1915) visited several districts in the Northern Territory, including the Daly and Alligator Rivers, and Bathurst and Melville Islands; they found no signs of malaria among the natives in any of these localities either on blood examination or spleen palpation. In the same report it is mentioned that Holmes in 1912 found four out of twenty natives examined on Melville Island to be suffering from malignant tertian malaria, from which it is clear that within three years the disease had disappeared from the island without any special anti-malarial measures being taken.

The only other published records of malaria in the Northern Territory are those in the Annual Health Reports and in the Annual Reports of the Darwin Hospital. A brief outline of the local conditions will indicate that the figures in Table IV are only very approximate.

The total area of the Northern Territory of Australia is well over 500,000 square miles; there is only one* medical officer in the whole country and he spends practically the whole of his time in Darwin. For this reason most of the cases of sickness reported, and of deaths registered, are not certified by a qualified man, but are furnished by the local police; consequently the only reliable returns are those for the Darwin Hospital. In the year 1918 the highest population since 1910 was recorded, and this is given in Table III along with the latest figures available.

TABLE III.
Population of the Northern Territory.

Year	Europeans	Asiatics	Half-castes	Total
1918	3767	1177	118	5062
1921	2478	1094	?	3572

* From 1911 to 1915 there were four medical officers in the Northern Territory, and two of them did considerable travelling.

The aborigines consist of numerous small nomadic tribes, hence their numbers cannot be accurately determined. The most reliable estimate of the number of natives that the writer has ever been able to obtain, was given to him about ten years ago by an official who had spent over forty years in the country and who had travelled practically all over it. This officer was of the opinion that there were not more than 30,000 natives in the whole country. Although far from being precise these figures at any rate indicate that it is very thinly populated.

TABLE IV.

Malaria records for the Northern Territory

Year	Total Number of cases reported	Cases treated in Darwin Hospital	Deaths	Remarks
1897...	?	18	7	
1898...	?	8	8	
1899...	?	6	5	
1900...	?	5	6	
1901...	?	1	9	
1902...	?	1	6	
1903...	?	2	6	
1904...	?	12	8	
1905...	?	1	0	
1906...	?	6	0	
1907...	?	12	7	
1908...	?	23	16	
1909...	?	44	18	
1910...	?	27	18	
1911...	?	11	3	
1912...	?	12	0	
1913...	?	6	1	
1914...	1	—	0	
1915...	—	—	—	
1916...	'Prevalent'	?	15	For 18 months ending 30.6.1917
1917...	—	—	—	
1918...	45	?	?	
1919...	—	—	—	Not available
1920...	59	?	?	
1921...	'Many cases'	24	2	

In addition to the above table the following extracts from the Health Reports are appended.

1912. Malaria is not as prevalent as it is popularly supposed to be. The only death ascribed to malaria is registered 'kidney troubles and fever.' Practically all deaths outside Darwin are registered by the police, so the accuracy of the diagnosis is extremely doubtful. Malaria

is unknown at Pine Creek and Darwin, the two largest settlements. Some cases of malaria were found among the natives on Melville Island.

1913. The single death registered as due to malaria was diagnosed by a layman. Two of the medical officers travelled extensively during this year and only one case of malaria was seen, although this disease was specially looked for, and no cases were found on Melville Island where it was seen the year before.

1915-1917. Malaria was 'very prevalent' in several localities, e.g., the Pine Creek railway extension camps and Maranboy mining field. More than 50 per cent. of the cases were only diagnosed clinically, and although it is not stated, it is almost certain that a number of the cases were not seen at all by a medical man. It is considered that malaria is not endemic.

1918. One case was contracted in Darwin.

NOTE.—This is the only record of a case contracted in Darwin that the writer can find.

1920. All of the 59 cases reported for the year came from the country districts and were of a mild form. Three more serious cases were apparently contracted elsewhere.

1921. Many cases have occurred during the past few months, none of which were contracted in Darwin. The increase of the past few years is ascribed to the introduction of returned soldiers with parasites in their blood.

NEW SOUTH WALES

Early in the year Jamieson (1915) reported a case of malaria which the evidence showed to have been contracted at Gosford not far from Sydney. Commenting on this case, Cleland (1915) stated that apart from unreliable records in the comparatively early days of settlement he only knew of one other case contracted in the State. This was in a baby a few days after birth, who was born of a mother suffering from malaria at the time; he considers this to be a case of direct infection.

On the 17th March, 1915, 'Acute malaria' was made compulsorily notifiable throughout New South Wales; this regulation continued in force until 28th November, 1919, when it was withdrawn. The annual figures for this period are given in Table V.

TABLE V.

Cases of malaria notified in New South Wales.

Year	Number of cases
1915	105
1916	61
1917	17
1918	11
1919	35

It is not stated in these returns whether any of the cases were locally acquired, and all that can be gathered in this respect is that in 1915 the Chief Health Officer in his letter of presentation of the annual report states, that of the 105 cases recorded in that year, all except 14 were returned soldiers; it is, of course, possible that all of the fourteen cases who were not soldiers also acquired their infections in other countries.

There are two other records of isolated cases which seem beyond doubt to have been contracted in New South Wales; one of these was reported by Evans (1919) at Wyong, and the other by Clayton and Utz (1921) near Tumbarumba. This completes the published record of malaria for New South Wales.

VICTORIA

Doyle (1921) reported a case of malaria at St. Arnaud, which was locally acquired. As far as can be ascertained this is the only case of malaria ever recorded in Victoria.

In South Australia and Tasmania there is no evidence that malaria has ever occurred. The North-west of Western Australia which adjoins the Northern Territory is comparable to the latter both in its malaria incidence and conditions of living. No references to malaria in this part of the country can be found in the literature, nor are the Government reports from this State available, so actual figures cannot be given.

The writer had spent altogether upwards of five years in North Queensland and the Northern Territory (see map, places underlined), and during that time he has seen only two cases of malaria contracted in the country, the small outbreak on Palm Island in 1921 excepted. Experience has led him to the conclusion, that the inhabitants of Tropical

Australia are prone to ascribe all their ills to malaria and that this opinion is rarely confirmed by microscopic diagnosis.

The tendency of the layman to exaggerate the incidence of malaria reacts on the police, who in the absence of medical assistance are inclined to register all deaths not clearly due to violence as due to malaria. These figures are given in the annual health reports and so the popular and erroneous opinion of the prevalence of malaria is to some extent supported in official returns.

ANOPHELINE MOSQUITOES FOUND IN AUSTRALIA

According to Ferguson (1921) only five species of Anophelines have ever been recorded in Australia. They are :—

1. *A. corethroides*, Theobald, 1907.
2. *A. (Pyrethrophorus) atratipes*, Skuse, 1888.
3. *A. (Pyrethrophorus) stigmaticus*, Skuse, 1888.
4. *A. (Nyssorhynchus) annulipes*, Walker, 1850.*
5. *A. (Myzorhynchus) barbirostris*, de Wulp, var. *bancrofti*, Giles, 1902.

A. corethroides is only found in South Queensland.

A. atratipes was recorded by Bancroft (1908) from South Queensland and it was also recorded earlier by Skuse at Berowra, New South Wales.

A. stigmaticus has been recorded only once from a single locality in New South Wales.

These three species are only found in parts of Australia where malaria does not occur and are so restricted in distribution that they cannot have any bearing on the spread of this disease at the present time. The other two species, viz., *A. annulipes* and *A. bancrofti* are much more widely spread and as, from circumstantial evidence which is all that is available, they seem to be connected with malaria, their occurrence will be considered in more detail.

Distribution of *A. annulipes*. Hill (1922) summarises the distribution of this species as follows :—‘*A. annulipes* is undoubtedly the most widely-distributed Anopheline found in Australia, having been recorded from Tasmania northwards to Banks Island (Torres Strait), and from South Australia, Central Australia, Northern Territory, South-west Australia, and North-west Australia. It is most probable that it does not occur in the elevated districts of South Australia and North Queensland (Atherton Tableland), and possibly not in some of the arid inland districts,

* Until recently, another species *Anopheles amictus* Edwards, 1921, has been confused with *A. annulipes*. *A. amictus* occurs at Townsville, Palm Island and Port Darwin. [Editors.]



although its presence in such localities as Wire Creek Bore and Lander Creek (Central Australia), indicates that only the absence of suitable breeding places would inhibit its existence in the latter.'

Distribution of *A. bancrofti*. This species is not so widely spread as *A. annulipes*. Hill states that it is found only in the coastal districts of Queensland, some of the Torres Straits Islands, and the ' . . . Northern (coastal) districts of the Northern Territory . . .' but one of the localities given by Hill, viz., Horseshoe Creek is over 150 miles from the coast. As it is possible that this species has more to do with malaria in Australia than has hitherto been supposed, it is proposed to consider the records of its occurrence in more detail. These are summarised in Table VI.

TABLE VI.
Principal records of the occurrence of *A. bancrofti* in Australia.

Locality	By whom recorded	Remarks
Brisbane	Bancroft (1908)	Found in the scrub from Enoggera to Caboolture; males, larvae, and eggs never found.
Brisbane	Cooling (1913)	Once taken in a house; a few females taken in the scrub; no larvae found.
Brisbane	Cooling (1914)	Four specimens taken for the whole year.
Rockhampton	Taylor (1916)	Numerous adults, no larvae.
Burdekin River	Taylor (1913)	
Townsville	Taylor (1913)	Hill (1922), writes that he has failed to find the species over a period of 2½ years' continuous observation and concludes that it has died out.
Halifax	Taylor (1916)	
Palm Islands	Hill (1922)	Plentiful within 200 yards of No 2 aboriginal camp and close behind main camp. <i>A. annulipes</i> not taken nearer than ¼ mile of camp clearing.
Cairns	Taylor (1916)	
	Taylor and Breinl (1918)	Numerous, and breeding freely in swamps in and around town.
Northern Territory	Hill (1922)	Twelve distinct localities given, including Melville and Bathurst Island (see map). <i>Note.</i> —The mosquito observations in the N.T. are more thorough than in any part of Tropical Australia except for a small area round Townsville.

With the exception of Brisbane, Townsville, Cairns and to some extent the Northern Territory, the records in Table VI refer to a single observation. It is probable that more extended work would reveal the presence of *A. bancrofti* in many other parts of Northern Australia, but it is unlikely that this species exists far south of Brisbane, because it has never been recorded in New South Wales at all, and the knowledge of mosquitoes in this State is much more advanced than it is in Queensland. In fact, as far as the records go, there is some evidence that *A. bancrofti* is not found in any numbers south of about 19° South Latitude.

THE INSECT VECTOR OF MALARIA IN AUSTRALIA

The Medical Journal of Australia has on more than one occasion (Leading articles, 1915, p. 171 and 1921, p. 512, etc.), pointed out that the mosquito carrier of malaria has not yet been determined. Breinl (1912) stated that *A. annulipes* was the probable vector at Umbrawarra; in support of this he quotes the successful experiment of Kinoshita (1906), who successfully infected *A. annulipes* with *Plasmodium falciparum* in Formosa. A little later Breinl (1914) definitely stated that *A. annulipes* was the carrier of malaria in Australia, but quoted no authority. Since these two references *A. annulipes* has been frequently mentioned in the medical literature of Australia, being variously described as 'the probable carrier,' 'the presumed carrier,' 'the carrier,' etc., but in most cases no authority is given, and when it is, Kinoshita (1906) is the only reference. The statement by Harrison (1922) is an accurate summary of the present state of our knowledge in this respect, when he says that there is evidence that the local Anophelines are capable of acting as intermediate hosts for malaria parasites.

The only record of *A. annulipes* as a malaria carrier given by Chanal (1921), is the single experimental result obtained by Kinoshita already referred to; Chanal's conclusion is that *A. annulipes* should be classed as dangerous. But it should be noted that although Kinoshita states that he infected 60 per cent. of his mosquitoes, a detailed study of his experiments shows that he used the species on three occasions. The first time, out of five fed, all died within three days, the second time nine insects were used and all died within three days of feeding, the third time eight mosquitoes were used, of which three died within three days

and three of the remaining five became infected. It is this result Kinoshita gives as 60 per cent. positive; only *P. falciparum* was used.

A. bancrofti seems by common consent to have been almost completely ignored as a possible malaria carrier in Australia, for the only references to this species in this connection are the following, viz.:—Cleland (1910) includes it in a list of the then known malaria carriers. It is next mentioned by Cooling (1914) who suggests that it may be a malaria carrier, because Stephens and Christophers (1902) were successful in infecting *A. barbirostris* in the laboratory in India. Since that date, according to Chanal (1921), *A. barbirostris* has been found in nature and infected in the laboratory both with *P. falciparum* and *P. vivax* on several occasions in various parts of the Malay Archipelago; but as all these records refer to a different variety of the species which does not occur in Australia, they have no bearing on the subject. One other reference to *A. bancrofti* as a malaria carrier is made by Breinl (1915) who, in an article on New Guinea, states that *Nyssorhynchus bancrofti** is not a malaria carrier. This statement is not supported by any evidence.

With regard to the distribution of Anophelines in Australia, Breinl (1914) says, ' . . . The distribution of malaria in Australia corresponds, on the whole, with the incidence of the mosquito *Nyssorhynchus annulipes* . . . It is curious to note that there are localities where the mosquito has been found, but where malaria is practically non-existent.'

Again, Breinl and Taylor (1918) remark, ' . . . *Nyssorhynchus annulipes* which, judged by its distribution in relation to malarial infested regions in Northern Australia, most probably acts as a malaria carrier . . . '

These two statements may be more or less correct as far as they go, but they do not explain why malaria is practically never found far south of Cairns, whereas *A. annulipes* is spread all over Australia. If the explanation of the restriction of malaria to Northern Australia is to be found in the distribution of a special Anopheline, it will be found that the occurrence of *A. bancrofti* much more nearly corresponds with the malaria distribution than does *A. annulipes*. *A. bancrofti*, however, also exhibits one or two striking exceptions to the rule, so it is considered that the peculiar distribution of malaria in Australia is due to other causes, not yet ascertained.

* *Nyssorhynchus bancrofti* is obviously the species intended, for Taylor (1914) in the list of mosquitoes taken by Breinl on this expedition includes it, and as far as the writer can ascertain there is no such species as *Nyssorhynchus bancrofti*.

As far as the writer can find out, the only explanation that has ever been offered as to why malaria fails to become established in the greater part of Australia is the mathematical hypothesis of Ross (1910); all the authors who mention this subject are of the opinion that there are too few mosquitoes or too few susceptible human beings in most parts of Australia. It is unlikely this is the sole reason, if it is the reason even in part, for it is by no means in the most thickly populated parts of Australia where Anopheline mosquitoes are found that malaria outbreaks occur.

There is another set of conditions which seem to the writer worthy of consideration, and which have never been considered, and that is the relation between malaria outbreaks and meteorological records. Gill (1920 and 1921a) has studied the incidence of malaria in parts of India along with the mean temperature and relative humidity readings, and the same author (1921b) extended his observations to England. As a result of this work he considers it probable, that before malaria is able to spread in a locality it is necessary to have a monthly minimum mean temperature of 61° F. and a minimum mean relative humidity of 63 per cent. At the same time he points out this is not yet conclusively proved. In this connection it is worth noting that in Kinoshita's successful experiment with *A. annulipes* the temperature remained between 28° and 30° C. the whole time, and in his conclusion he states that complete development of the oocysts of *P. falciparum* cannot take place in this mosquito except in a high and unvarying temperature.

SUMMARY

As far as can be gathered from the incomplete and unreliable records available, malaria is only mildly endemic in Australia north of 19° South Latitude. *A. annulipes* and *A. bancrofti* the only two possible malaria carriers in Australia under present conditions are much more widely distributed than is malaria.

In various localities north of 19° South Latitude small epidemics of malaria occur from time to time; these outbreaks are of short duration, their origin is generally traceable to the introduction of malaria carriers from abroad, the disease does not spread to adjoining camps and towns, and soon dies out, without any very active anti-malarial measures being instituted.

The scarcity of population and Anopheline mosquitoes is not a satisfactory explanation of the absence of malaria from the greater part of Australia.

It is of the first importance to discover the mosquito carriers of malaria in Australia, and when this has been done, work along the lines of Gill in India and England would possibly yield interesting and valuable results.

REFERENCES

- *A'HEARNE, J. A. (1890). Presidential Address to the North Queensland Medical Association. *Aust. Med. Gaz.*, August, p. 293.
- BANCROFT, T. L. (1908). List of the Mosquitoes of Queensland. *Ann. Qld. Mus.*, No. 8, p. 10.
- BREINL, A. (1911). Report of Aust. Inst. Trop. Med. for 1910, p. 21.
- (1912). Report on Health and Disease. *Bull. No. 12, Northern Territory*, p. 11.
- (1914). The Distribution and Spread of Disease in the East. *Stewart Lect. No. 1, Univ. Melb.*, 1913.
- (1915). On the Occurrence and Prevalence of Diseases in British New Guinea. *Ann. Trop. Med. & Parasitol.*, Vol. IX, p. 289.
- BREINL, A., and HOLMES, M. J. (1915). Medical Report on the data collected during a journey through some districts of the Northern Territory. *Bull. No. 15, Northern Territory*.
- BREINL, A., and TAYLOR, F. H. (1918). A Malarial Survey of the Township of Cairns. *Med. Journ. Aust.*, Vol. II, p. 109.
- *BROWNE, G. (1890). *Aust. Med. Gaz.*, p. 322.
- CHANAL, L. (1921). Rôle Pathogène des Moustiques, etc. *Travail du Lab. de Parasit. de la Fac. de Méd.*, pp. 13 and 14.
- CLAYTON, J. H., and UTZ, L. (1921). A Case of Malaria infected in the Riverina, New South Wales. *Med. Journ. Aust.*, Vol. I, p. 382.
- CLELAND, J. B. (1910). Flies and Disease. *Rep. Govt. Bureau, Microbiol. N.S. Wales for 1909*, p. 52.
- (1914). Contributions to the History of Disease of Man in Australia. *Ibid.* 3rd Rep., p. 226.
- (1915). Malaria in New South Wales. *Med. Journ. Aust.*, Vol. I, p. 316.
- COOLING, L. E. (1913). Report on Mosquito Work in Brisbane. *Append. J., Ann. Rep. Commr. Pub. Health, Queensland*, p. 59.
- (1914). Second Progress Report of the Campaign against Mosquitoes in Brisbane. *Append. H. Ibid.* (1914), p. 63.
- DOYLE, G. (1921). Clinical Reports of Two Unusual Cases. *Med. Journ. Aust.* Vol. I, p. 421.
- ELKINGTON, J. S. C. (1912). Quarantine in Australia. *Aust. Med. Gaz.*, p. 434.
- EVANS, W. (1919). Anti-malaria Work with the Australian Mounted Division in Palestine. *Med. Journ. Aust.*, Vol. II, p. 529.
- FERGUSON, E. W. (1921). The Malaria Danger. *Med. Journ. Aust.*, Vol. I, p. 432.
- GILL, C. A. (1920). The Relationship of Malaria and Rainfall. *Ind. Journ. Med. Res.*, Vol. VII, p. 618.
- (1921a). The Rôle of Meteorology in Malaria. *Ind. Journ. Med. Res.* Vol. VIII, p. 633.
- (1921b). Malaria in England with special reference to the Rôle of Temperature and Humidity. *Journ. of Hyg.*, Vol. XIX, p. 320.

* Original papers not consulted.

- HARRISON, L. (1922). Flies and Infectious Disease. *Med. Journ. Aust.*, Vol. II, p. 490.
- HILL, G. F. (1922). Notes on the Habits and Distribution of some North Australian Culicidae. *Commonwealth Health Dept. Service Pub. No. 21*.
- HOLMES, M. J. (1913). Report of the M.O.H. for Year 1912. *Rep. Adminis. N. Terr.*, p. 53.
- *HUNT, J. S. (1890). The Evolution of Malaria. *Aust. Med. Gaz.*, p. 75.
- *JAMES, P. (1891). Remarks on the Fevers and Diseases of Tropical Queensland. *Ibid.*, p. 300.
- JAMIESON, S. (1915). Malaria arising in a non-malarial District. *Med. Journ. Aust.*, Vol. I, p. 163.
- *JEFFRIS-TURNER, A. (1890). *Aust. Med. Gaz.*, p. 65.
- KINOSHITA, K. (1906). Über die Verbreitung der Anophelen auf Formosa und deren Beziehungen zu den Malariakrankheiten. *Archiv. f. Schiff.-und Tropenbyg.*, Vol. X, p. 714.
- *O'BRIEN, R. A. (1908). Notes from North Queensland. *Aust. Med. Gaz.*, p. 121.
- ROSS, R. (1910). The Prevention of Malaria.
- STEPHENS, J. W. W., and CHRISTOPHERS, S. R. (1902). The Relation of Species of Anopheles to Malaria Endemicity. *Reports to the Malaria Comm. Roy. Soc.*
- TAYLOR, F. H. (1913). Report of the Entomologist. *Aust. Inst. Trop. Report for 1911*, p. 49.
- (1914). Culicidae from Papua. *Trans. Ent. Soc. Lond.*, Pt. I.
- (1915). Report for the Half-year ending June 30th. *Aust. Inst. Trop. Med. Half-yearly Rep.*, p. 20.
- (1916). Report of the Survey of the Distribution of *Stegomyia fasciata* in the Ports of Queensland. *Aust. and Yellow Fever. Quarantine Ser. Pub.*, No. 6, p. 57.
- (1917) Malaria Mosquito Survey of the Irrigation areas in the Murray River District *Ibid.*, No. 12.
- *WHITE, J. A. (1867). On the Fevers of the Gulf of Carpentaria. *Aust. Med. Gaz.*, Vol. XII, p. 361.
- *WOOD, P. M. (1889). Intercolonial Medical Congress Report, p. 54.

* Original papers not consulted.